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Reproducibility and Differential Item Functioning of the Alcohol Dependence Syndrome Construct across Four Alcohol Treatment Studies: An Integrative Data Analysis

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Abstract

Background—The validity of the alcohol dependence syndrome has been supported. The question of whether different measures of the construct are comparable across studies and patient subgroups has not been examined. This study examined the alcohol dependence construct across four diverse large-scale treatment samples using integrative data analysis (IDA).

Method—We utilized existing data ($n=4,393$) from the COMBINE Study, Project MATCH, the Relapse Replication and Extension Project (RREP), and the United Kingdom Alcohol Treatment Trial (UKATT). We focused on four measures of alcohol dependence: the Alcohol Dependence Scale (COMBINE and RREP), Alcohol Use Inventory (MATCH), the Leeds Dependence Questionnaire (UKATT), and the Diagnostic and Statistical Manual of Mental Disorders (COMBINE and MATCH). Moderated nonlinear factor analysis was used to create a measure of alcohol dependence severity that was moderated by study membership, gender, age, and marital status.

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Contributors. All authors had full access to the data and take responsibility for the integrity of the data. Dr. Witkiewitz conducted all analyses and takes responsibility for the accuracy of the data analysis. Dr. Hallgren, Mr. O'Sickey and Mr. Roos assisted with creating the combined datasets. Drs. Witkiewitz and Maisto were responsible for the study concept and design. Dr. Witkiewitz drafted the manuscript and all authors provided critical revisions of the manuscript and approve of the final manuscript.

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Results—A commensurate measure of alcohol dependence severity was successfully created using 20 items available in four studies. We identified differential item functioning by study membership, age, gender, and/or marital status for 12 of the 20 items, indicating specific patient subgroups who responded differently to items based on their underlying dependence severity.

Conclusions—Alcohol dependence severity is a single unidimensional construct that is comparable across studies. The use of IDA provided a strong test of the validity of the alcohol dependence syndrome and clues as to how some items used to measure dependence severity may be more or less central to the construct for some patients.

Keywords

alcohol dependence syndrome; integrative data analysis; moderated nonlinear factor analysis; alcohol use disorder; alcohol treatment

1. INTRODUCTION

The alcohol dependence construct is central to theories of problem alcohol use (Stockwell, 2015). However, the reproducibility of the alcohol dependence construct across studies and settings is not well known. There have been numerous psychometric studies of individual measures of alcohol dependence (Doyle and Donovan, 2009; Kahler et al., 2003a), but no studies have attempted to examine the construct of alcohol dependence across measures, studies, and patient subgroups. The goal of this study was to use integrative data analysis to test the construct of alcohol dependence severity among 4,393 patients presenting for alcohol use disorder (AUD) treatment.

1.1. Alcohol Dependence Syndrome

Edwards and Gross (1976) hypothesized that alcohol dependence syndrome was a collection of symptoms including narrowing of the drinking repertoire, salience of drink-seeking behavior, tolerance, drinking to relieve withdrawal symptoms, awareness of compulsion to drink, and return to drinking following abstinence. The dependence syndrome is primarily focused on physiological, psychological and behavioral symptoms that result in a core “drive to consume alcohol” (p. 79; Stockwell et al., 1979) and is therefore distinct from alcohol consumption, in and of itself, or negative consequences that result from alcohol use (Li et al., 2007). Almost 40 years of research on the dependence syndrome (Marshall, 2015; Stockwell, 2015) has supported the importance of the concept for the clinical formulation of AUD. Yet, the degree to which certain elements of the syndrome are central to the construct or subgroups (e.g., females) has received little attention (Kahler et al., 2003b), and no study has examined whether different measures of dependence are measuring the same construct across AUD samples.

1.2. Integrative Data Analysis (IDA)

IDA is a framework for merging, analyzing, and comparing information from multiple studies (Curran and Hussong, 2009). Numerous methods associated with IDA exist, including moderated nonlinear factor analysis (MNLFA; Bauer and Hussong, 2009), individual participant data meta-analysis (Cooper and Patall, 2009; Huh et al., 2015), and

item response theory (McArdle et al., 2009). The primary requirements for IDA are to have multiple studies with common measures that reflect similar constructs (Bauer and Hussong, 2009).

In the current study we utilized MNLFA (Bauer and Hussong, 2009; Curran et al., 2014), which allowed for the empirical testing of whether items are measuring the same construct across subpopulations, including individuals from different studies and with different demographic characteristics. Tests of differential item functioning (DIF; e.g., items not measuring the same construct the same way across groups) can yield insights about the clinical value of certain items and item responses that may differentially reflect the construct in different groups.

1.3. Goals of Current Study

The goal of this study was to examine whether the construct of alcohol dependence, as measured by different measures of alcohol dependence severity, was reproducible across studies. The pooling of data across studies provided greater statistical power and greater study heterogeneity to test for DIF. We had no *a priori* hypotheses regarding DIF given lack of prior research in this area among patients with AUD.

2. MATERIAL AND METHODS

2.1. Source of Data

The data for this study were drawn from four adult alcohol treatment studies ($N=4,414$). Exclusion criteria and participant demographics are provided in Table 1.

2.1.1. COMBINE Study—The COMBINE study (COMBINE Study Group, 2003), conducted between 2001 and 2004, randomized participants ($n=1,383$) from eleven research sites across the United States into nine treatment groups consisting of medical management or combined behavioral intervention and medications (acamprosate, naltrexone, or placebo).

2.1.2. Project MATCH—Project MATCH (Project MATCH Research Group, 1997), conducted between 1991 and 1993, randomized outpatients ($n=952$) and aftercare patients (recruited from inpatient treatment; $n=774$) from nine research sites across the United States into three treatment groups: Cognitive Behavioral Therapy, Motivational Enhancement Therapy, or Twelve-Step Facilitation.

2.1.3. Relapse Replication and Extension Project (RREP)—RREP (Lowman et al., 1996), conducted in the early 1990s, was a longitudinal observational study of individuals ($n=563$) from community treatment programs associated with three research sites in the United States.

2.1.4. United Kingdom Alcohol Treatment Trial (UKATT)—UKATT (UKATT Research Team, 2001), conducted between 1998 and 2001, recruited participants ($n=742$) across seven treatment sites in the United Kingdom and randomized them into Motivation Enhancement Therapy or Social Behavior and Network Therapy (UKATT Research Team, 2005).

2.2. Measures

The four studies administered a variety of measures that were used to develop a commensurate measure of baseline alcohol dependence severity (Table 1). The following demographic covariates were included: gender (male=1); marital status (married or cohabitating=1); and age.

2.2.1. Dependence Severity—The Alcohol Use Inventory (AUI; Horn et al., 1990), used in MATCH, consisted of 147 items that measure various alcohol involvement constructs, such as thoughts about alcohol and alcohol-related problems, perceived benefits from drinking, and consequences of drinking. The Alcohol Dependence Scale (ADS; Skinner and Horn, 1984), used in COMBINE and RREP, was originally developed by Skinner (1981), who conducted a factor analysis of the AUI (Horn et al., 1974) to develop the 29-item ADS. The ADS was further reduced to 25 binary and Likert-type items (e.g., 0=“never” to 3 “almost every time I drink”) assessing withdrawal symptoms, impaired control, compulsion to drink, alcohol tolerance, and alcohol-seeking behaviors occurring during the past 12 months (Skinner and Horn, 1984) with the instruction to “Answer each question by circling the one choice that is most true for you.” For the current study, we included the 23 items from the ADS and the AUI that were overlapping, resulting in 23 identical items in Project MATCH, RREP, and COMBINE.

The Leeds Dependence Questionnaire (LDQ; Raistrick et al., 1994), used in UKATT, assesses the psychological aspects of alcohol dependence (excluding aspects of tolerance and physiological withdrawal). The 10-item LDQ provides the following instructions: “Think about your drinking in the last week and answer each question ticking the closest answer to how you see yourself” and uses a Likert-type scale ranging from 0=“never” to 3=“nearly always.”

The presence of physiological dependence was assessed by the Structured Clinical Interview for Diagnostic and Statistical Manual for Mental Disorders – Third Edition Revised (DSM-III-R; APA, 1994; Spitzer and Williams, 1985) in Project MATCH and the Structured Clinical Interview for DSM – Fourth Edition (DSM-IV; APA, 1994; First et al., 2002) in COMBINE. In both versions of the DSM, physiological dependence was indicated by the presence of tolerance and/or withdrawal within the past 12 months.

Items of the ADS, AUI, DSM-III-R, DSM-IV, and LDQ were dichotomized (0=no, never present; 1=yes, symptom present) to harmonize response scales across studies and to reduce sparseness observed in response levels for some items. The internal consistency of the dichotomized items were acceptable in all four studies (COMBINE ADS $\alpha=0.85$; RREP ADS $\alpha=0.89$; MATCH AUI $\alpha=0.85$; and UKATT LDQ $\alpha=0.92$).

2.2.2. Alcohol Consumption and Alcohol Problems—Concurrent validity of the dependence severity construct was assessed by examining associations with baseline alcohol consumption and alcohol-related problems. Alcohol consumption (defined as percent drinking days and drinks per drinking day) was assessed in all studies using the Form-90 (Miller, 1996). Alcohol-related problems were assessed via the Drinker Inventory of

Consequences (DrInC; Miller et al., 1995) in COMBINE, MATCH and RREP, and the Alcohol Problems Questionnaire (APQ; Williams and Drummond, 1994) in UKATT.

2.3. Statistical Analyses

2.3.1. IDA Steps—First, we examined distributions of the data at the item level and identified “linking items,” which are items from a measure that closely resemble the items of a different measure. Second, we tested the dimensionality of the construct and individual item factor loadings using exploratory factor analysis (EFA). Third, we tested factor and item differences across study and demographic covariates using moderated nonlinear factor analysis (MNLFA; Bauer and Hussong, 2009; Curran et al., 2014). MNLFA can address numerous challenges that may arise when combining measures across studies, including DIF and the lack of common items across studies. Fourth, we used estimates from the MNLFA to generate expectation a posteriori (EAP) scale scores that had the same metric across studies and also accounted for DIF identified during the MNLFAs. Fifth, we evaluated the EAP scale scores using descriptive analyses.

2.3.2. Model Estimation—Models were estimated using Mplus version 7.3 (Muthén and Muthén, 2012). For EFA models, we used diagonally weighted least squares estimation with a probit link function and mean- and variance-adjusted chi-square tests of model fit. EFA models were considered to provide a reasonable fit to the data if the Root Mean Square Error of Approximation (RMSEA; Browne and Cudeck, 1993) < 0.06 and the Comparative Fit Index (CFI; Bentler, 1990) > 0.95. For the MNLFA models we used maximum likelihood estimation with adaptive quadrature numerical integration with a logit link function, which allowed for missing data within and across studies.

2.3.3. Missing Data—Individuals with missing data on covariate measures ($n=22$) were not included, reducing the sample size from the combined $N=4,414$ to $n=4,393$ (99.5% of the sample retained). Analyses revealed no systematic differences between those with and without missing covariate data on any outcomes of interest.

3. RESULTS

3.1. Item Analysis and Identification of Linking Items

3.1.2. Item analysis—Graphical and descriptive analyses of the 23 AUI/ADS items, the DSM item, and the 10 LDQ items indicated there were similar frequencies of responses across studies. Evaluation of the item content suggested that thirteen of the AUI/ADS items and one of the LDQ items appeared to be measuring consequences of drinking (e.g., “passed out”) and level of alcohol consumption (e.g., “how much did you drink”). Given our ultimate goal of examining associations between alcohol dependence severity, alcohol-related problems, and alcohol consumption, we deleted these fourteen items.

3.1.3. Identification of linking items—Two LDQ items were identified as linking items to the AUI/ADS items given item overlap: (1) “find yourself thinking about when you will next be able to have another drink” was selected as a linking item for the AUI/ADS item “constantly think about drinking and alcohol”; and (2) “drink alcohol morning, afternoon

and evening” was selected as a linking item for the AUI/ADS item “drink throughout the day.” Subsequent analyses utilized one item from DSM (physiological dependence), ten unique AUI/ADS items, seven unique LDQ items, and two linking items for a total of 20 items (Table 3).

3.2. Exploratory Factor Analysis (EFA)

The dimensionality and item loadings of the dependence severity measure were estimated using EFA. First, items from the AUI/ADS, the two linking items from the LDQ, and the DSM item were estimated in an EFA with all available data from each study. All indicators were assumed to be conditionally independent, and the latent factor variance and residual variances were assumed to be normally and independently distributed. Results from this EFA supported a one-factor dependence severity measure with adequate model fit based on RMSEA and CFI ($\chi^2 (65)=776.19, p < 0.001$, RMSEA=0.05 (90% CI 0.047, 0.053); CFI=0.95), eigenvalues (1st eigenvalue=6.4; 2nd eigenvalue=1.4), and all standardized factor loadings exceeded 0.50. A two-factor solution was also considered acceptable based on parallel analysis and eigenvalues > 1.0, however in a two factor solution there were several items with factor loadings less than 0.40. Given the model fit and the larger factor loadings for a one-factor model we ultimately decided that a one-factor solution was acceptable. Second, we examined a one-factor alcohol dependence severity measure using the nine LDQ items. Results from this EFA also supported a one-factor model of dependence severity based on RMSEA and CFI ($\chi^2 (27)=120.37, p < 0.001$, RMSEA=0.06 (90% CI 0.056, 0.081); CFI=0.98), eigenvalues (1st eigenvalue=5.9; 2nd eigenvalue=0.9), and all standardized factor loadings exceeded 0.50.

3.3. Moderated Nonlinear Factor Analysis (MNLFA)

The 20-item one-factor model of alcohol dependence severity was then estimated using MNLFA to test the impact of study membership, demographic covariates (age, gender, marital status), and the study-by-demographic covariate interactions on the factor mean, factor variance, item intercepts, and item loadings. First, we examined the effects of study and covariates on the latent factor mean and variance in one model (Step 1). Next, we retained all significant covariate effects of latent factor means and variances identified in Step 1 and estimated the effects of study, covariates, and study-by-covariate interactions on the item intercepts and loadings in 20 different models corresponding to the 20 items (Step 2). We then we estimated a simultaneous model with all significant covariate effects from Steps 1 and 2 retained (Step 3). Step 3 was then repeated to trim covariate effects that were non-significant (using $p < 0.01$ to adjust for multiple comparisons) in the simultaneous model.

3.3.1. Covariate effects on the factor mean and variance—As shown in Table 2, study membership, marital status, and age significantly predicted the mean of dependence severity. Married and cohabitating individuals scored lower on the dependence severity latent factor, than those who were unmarried, separated or divorced. The main effects of study and age were qualified by a significant interaction, such that older individuals in MATCH and RREP had greater dependence severity, as compared to those in COMBINE. Likewise, there was an interaction between study membership and marital status in

predicting the factor variance, such that married and cohabitating individuals in the COMBINE sample had less variability in dependence severity, whereas in the RREP and UKATT samples married or cohabitating individuals were more variable in alcohol dependence severity.

3.3.2. Covariate effects on the item intercepts and loadings—Individual item results are reported in Table 3 with significant DIF effects in italics. We found significant DIF for covariates on seven of the 20-item intercepts and three of the 20-item loadings. For those items with factor loading DIF we also added the terms for intercept DIF.

Item intercepts reflect the level of dependency severity associated with endorsement of each item, with lower values indicating a lower level of severity needed for positive endorsement. Covariate effects on item intercepts therefore reflect significant DIF in the probability of endorsing an item at the same level of underlying dependence severity. Covariate effects on item intercepts in the presence of covariate effects on the item loadings leads to greater complexity in the interpretation (as described later). In the absence of effects on factor loadings, a negative intercept DIF reflects a lower probability of endorsing the item at the same level of dependence severity for the group coded 1 and older individuals, whereas a positive DIF for an item intercept reflects a lower probability of endorsing the item at the same level of underlying dependence severity for the group coded 0 and younger individuals. For example, at the same level of alcohol dependence, males (coded 1) had a lower probability of endorsing ADS item 9 (“panic when you fear you may not have a drink”) than females. Individuals in COMBINE (coded 0), as compared to those in UKATT, had a lower probability of endorsing ADS18/LDQ1 (“constantly think about drinking”). Individuals in COMBINE, as compared to those in RREP, and females had a lower probability of endorsing ADS15/LDQ6 (“drinking throughout the day”). Younger individuals had a lower probability of endorsing ADS11 (“carry a bottle or keep one close”), and there was a significant study-by-gender interaction in endorsement of ADS11. In the MATCH aftercare sample females had a lower probability of endorsing ADS11, whereas in the COMBINE sample females and males did not differ in their probability of endorsing ADS11.

A more complex pattern of DIF was found for DSM physiological dependence, LDQ item 2 (“drinking more important than anything else”), and ADS item 5 (“had delirium tremens”). For each of these items there were both intercept and loading (i.e., non-uniform) DIF. Females needed to be at higher levels of severity to meet criteria for physiological dependence (intercept DIF), and physiological dependence was less strongly associated with the dependence latent factor for females, as compared to males. Individuals who were younger were less likely to endorse “drinking as more important than anything else” (LDQ2, intercept DIF), and there was a stronger association between LDQ2 and dependence severity among younger individuals (loading DIF). Younger individuals in COMBINE were less likely to endorse delirium tremens, and there was a positive association between endorsing delirium tremens and dependence severity that increased with age. In the MATCH aftercare sample, age was unrelated to likelihood of endorsing delirium tremens, and age was also unrelated to the relationship between delirium tremens and dependence severity.

3.4. MNLFA Scale Scoring

We used the final set of parameter estimates, adjusting for the factor and item covariate effects for the full integrated dataset to generate MNLFA scale scores. These had the same metric across studies and also accounted for DIF attributable to study (four items), age (three items), and gender (three items). The resulting MNLFA scores were generated for participants in all four studies.

3.5. Score Descriptive Statistics and Concurrent Validity with Measures of Alcohol Consumption

3.5.1. Score descriptive statistics—The distribution of MNLFA scores is provided in Figure 1. Outlier analyses by study, gender, marital status, and age revealed no outliers, and distributions were relatively normal with mild positive skew. The ranking of individuals on the MNLFA scores was also compared to the ranking of individuals on the ADS, DSM, and LDQ by examining the association between MNLFA scores and simple proportion scores (i.e., proportion of items endorsed on the ADS, DSM and LDQ). The MNLFA scores were significantly correlated with the proportion scores ($r=0.82$, $p < 0.001$), but the MNLFA scores also provided a broader distribution of scores than those computed using a simple proportion of items endorsed on each of the dependence measures. For example, Figure 2, patterned after Curran et al (2008), shows the distribution of MNLFA scores for the subset of participants who endorsed exactly 3 out of the 20 items. The MNLFA scores capture a broader distribution of the alcohol dependence continuum that also take into account the item parameters and any effects of covariates on item endorsement, by whom, and in which study. **3.5.2. Concurrent validity.** The association between the MNLFA scores, the ADS/LDQ/DSM measures, and measures of alcohol consumption were examined to assess concurrent validity. As shown in Table 4, the MNLFA scores were significantly positively correlated with other dependence measures, alcohol consumption, and alcohol-related problems. The pattern of correlations for the MNLFA scores suggested strong concurrent validity, particularly for drinks per drinking day and alcohol-related problems.

4. DISCUSSION

This study used IDA to examine the alcohol dependence syndrome construct as assessed via the ADS, AUI, LDQ, and DSM in four different alcohol treatment studies. Consistent with prior work, we found support for the dimensionality and concurrent validity of the alcohol dependence construct (Edwards, 1986; Stockwell, 2015).

The current study revealed several differences between subgroups in the functioning of items measuring dependence severity. Seven of the 20 item intercepts and three of the 20 item loadings showed DIF across study membership, age, and/or gender. The experience of delirium tremens showed the most complex pattern of DIF. Younger individuals in the COMBINE study had to be at higher levels of dependence severity to endorse delirium tremens. Similarly, females needed to be at higher levels of dependence severity to meet DSM criteria for physiological dependence. Clinically, these findings suggest that when working with younger and female patients the absence of delirium tremens and

physiological dependence, respectively, does not necessarily equate to lower severity of alcohol dependence, and presence of these symptoms indicates a higher degree of severity.

4.1. Limitations

IDA has several advantages, including the ability to combine data from diverse samples and provide larger sample sizes for testing moderation effects. The current IDA was also limited by the available data, and we were limited in the number of datasets and measures available for the current study. The availability of only two linking items in the analyses and only one linking item that did not have DIF by the UKATT study (ADS15. Drink throughout day/LDQ6. Drink morning, afternoon, evening), is an additional major limitation. For a unidimensional model, IDA only requires one linking item without DIF (Curran et al., 2014; Steenkamp and Baumgartner, 1998), however that is assuming the one linking item is truly equivalent across studies and that this one item is the right item for scaling the remaining items across samples. More complex measurement models require more items that are invariant across studies (see Mun et al., 2015).

Another limitation was the lack of inclusion of other demographic factors (e.g., race, employment, psychiatric comorbidity) that may also moderate responses to items measuring dependence severity. Lack of racial/ethnic diversity (particularly in the UKATT study) and differences in how demographic measures were assessed across studies prevented us from examining these covariates in the current study. There could also be historical effects that were not accounted for, namely the samples ranged in age from 18 to 80, thus cohort effects of alcohol use (Jager et al., 2013) could have been a factor that was not examined in the current analyses. The time frame of assessment also varied across studies, as the reference for the ADS, SCID, and AUI was the last 12 months, compared to the last week for the LDQ. Given the chronicity of alcohol dependence among treatment seekers with AUD, it is unlikely for these symptoms to change drastically from past week to past year, nonetheless the timing differences in measurement is a limitation of the current study. Finally, the items used in the current analyses did not include all elements of the dependence syndrome (e.g., “Reinstatement after abstinence” (p. 1060; Edwards and Gross, 1976)).

4.2. Clinical Implications and Future Directions

Findings provide further validation of the reproducibility of the dependence syndrome construct across four diverse alcohol treatment samples. The current study also provided evidence that certain indicators of dependence severity are less applicable in certain patient populations. For example, based on the current findings we see delirium tremens and physiological dependence as two indicators that may be less useful for assessing dependence severity in younger patients and females, respectively. Future studies should attempt to replicate the current findings and extend this work by examining other measures of dependence using IDA to gain a better understanding of how constructs may differ across studies, even when the same or similar items are used.

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Highlights

- Dimensionality of the alcohol dependence syndrome is reproducible across studies.
- Differential item functioning was found for all measures of dependence severity.
- Gender, age, marital status, and study predicted differential item responses.
- Certain items are more reflective of dependence in some subgroups.

Figure 1.
Distribution of MNLFA Scores by Study, Gender, and Marital Status

Figure 2.
Histogram of MNLFA Scores Associated with an Item Endorsement Proportion Score of 0.15 (indicating three of 20 items endorsed)

Table 1

Demographic Characteristics, Exclusion Criteria, and Alcohol Dependence Measures for COMBINE, MATCH, RREP, and UKATT.

Demographic characteristic	COMBINE	MATCH	RREP	UKATT
Sample size	1383	1726	563	742
Gender - % Male	69.1%	75.7%	58.8%	74.1%
Age – Mean (SD)	44.4 (10.2)	40.2 (10.9)	34.3 (8.7)	41.6 (10.1)
Ethnicity - % White	76.8%	80.0%	67.3%	95.6%
Marital status - % Married/cohabitating	46.3%	41.4%	17.9%	54.1%

Exclusion criteria	COMBINE	MATCH	RREP	UKATT
Age	18+	18+	18+	16+
Meet criteria for abuse/dependence	Past year	Past year	6 months	NA
Reading level	Literate	6 th grade	8 th grade	Literate
Comorbid psychiatric diagnoses	X	X	X	X
Unable to identify collateral informant		X	X	X
Severe cognitive impairment		X		X
Residential instability		X		X
Other illicit drug dependence	X	X		

Alcohol dependence measures	COMBINE	MATCH	RREP	UKATT
Alcohol Dependence Scale ^{a, b}	X		X	
Alcohol Use Inventory ^{a, b}		X		
Leeds Dependence Questionnaire ^b				X
DSM-III-R Physiological Dependence		X		
DSM-IV Physiological Dependence	X			

Note. DSM=Diagnostic and Statistical Manual for Mental Disorders;

^a =Share 23 items;

^b Share two linking items

Table 2

Dependence Severity MNLFA on Factor Mean and Variance

Covariate Effect	Estimate (SE)	<i>t</i>	<i>p</i> -value
Factor Mean			
MATCH Outpatient	−0.20 (0.06)	−3.42	0.001
MATCH Aftercare	0.50 (0.06)	8.71	<0.001
RREP	0.64 (0.08)	9.10	<0.001
UKATT	2.02 (0.14)	14.19	<0.001
Gender	0.04 (0.04)	0.86	0.39
Married	−0.25 (0.04)	−6.11	<0.001
Age	−0.01 (0.002)	−2.80	0.005
MATCH Outpatient x gender	−0.10 (0.12)	−0.83	0.41
MATCH Outpatient x married	0.13 (0.11)	1.18	0.24
MATCH Outpatient x age	0.02 (0.005)	3.96	<0.001
MATCH Aftercare x gender	0.13 (0.13)	0.99	0.32
MATCH Aftercare x married	−0.09 (0.11)	−0.78	0.43
MATCH Aftercare x age	0.02 (0.005)	3.55	<0.001
RREP x gender	−0.14 (0.12)	−1.09	0.28
RREP x married	−0.19 (0.16)	−1.17	0.24
RREP x age	0.04 (0.007)	5.27	<0.001
UKATT x gender	0.14 (0.12)	1.19	0.23
UKATT x married	−0.07 (0.11)	−0.67	−.50
UKATT x age	0.008 (0.005)	1.50	0.13
Factor Variance			
MATCH Outpatient	0.13 (0.10)	1.30	0.19
MATCH Aftercare	−0.05 (0.10)	−0.46	0.65
RREP	0.13 (0.12)	1.15	0.25
UKATT	−0.05 (0.21)	−0.22	0.82
Gender	0.14 (0.07)	1.86	0.06
Married	−0.19 (0.07)	−2.77	0.006
Age	0.01 (0.003)	1.32	0.19
MATCH Outpatient x gender	−0.005 (0.20)	−0.03	0.98
MATCH Outpatient x married	0.25 (0.19)	1.27	0.21
MATCH Outpatient x age	−0.004 (0.01)	−0.43	0.67
MATCH Aftercare x gender	−0.22 (0.22)	−0.98	0.33
MATCH Aftercare x married	0.36 (0.20)	1.80	0.07
MATCH Aftercare x age	−0.02 (0.01)	−1.47	0.14
RREP x gender	0.16 (0.21)	0.74	0.46
RREP x married	0.74 (0.26)	2.81	0.01
RREP x age	−0.001 (0.01)	−0.09	0.93
UKATT x gender	0.22 (0.22)	0.99	0.32
UKATT x married	0.50 (0.21)	2.41	0.02

Covariate Effect	Estimate (SE)	<i>t</i>	<i>p</i> -value
UKATT x age	−0.01 (0.01)	−0.94	0.35

Note. SE=standard error. Gender (0=female; 1=male); Marital Status (0=non married; 1=married or cohabitating); Study (0=COMBINE; 1=MATCH Outpatient, MATCH Aftercare, RREP, UKATT).

Table 3

Results from Final Scoring of Dependence Severity MNLFA with Covariate Effects ($p < 0.05$) on Item Intercepts and Factor Loadings

Item	Covariate	Intercept (SE)	Loading (SE)
ADS3. Had the shakes when sobering up		-2.23 (0.09)	1.62 (0.09)
ADS5. Had delirium tremens		-2.67 (0.16)	2.30 (0.16)
	<i>MATCH Outpatient</i>	-0.96 (0.19)	--
	<i>MATCH Aftercare</i>	-1.73 (0.50)	0.41 (0.41)
	<i>Age</i>	-0.03 (0.01)	0.05 (0.02)
	<i>MATCH Aftercare by Age</i>	0.07 (0.03)	-0.10 (0.03)
ADS7. Felt overly hot and sweaty as a result of drinking		0.23 (0.06)	1.26 (0.07)
ADS8. Seen things that weren't there as a result of drinking		-4.91 (0.29)	2.98 (0.23)
ADS9. Panic when you fear you may not have a drink if you need it		0.02 (0.09)	1.44 (0.08)
	<i>Gender</i>	-0.73 (0.10)	--
ADS11. Carry a bottle or keep one close		-2.63 (0.15)	1.59 (0.10)
	<i>MATCH Aftercare</i>	-0.73 (0.34)	--
	<i>Age</i>	0.03 (0.01)	--
	<i>Gender</i>	-0.11 (0.15)	--
	<i>MATCH Aftercare by Gender</i>	0.59 (0.37)	--
ADS 14. Had a convulsion following drinking		-3.99 (0.16)	1.29 (0.12)
ADS15. Drink throughout day/LDQ6. Drink morning, afternoon, evening		-0.14 (0.08)	1.29 (0.06)
	<i>RREP</i>	0.55 (0.13)	--
	<i>Gender</i>	0.40 (0.08)	--
ADS18. Constantly think about drinking/LDQ 1. Think about...next drink		-0.10 (0.06)	1.18 (0.06)
	<i>UKATT</i>	3.27 (0.18)	--
ADS19. Heard things that weren't really there as a result of drinking		-5.04 (0.32)	3.15 (0.25)
ADS20. Had weird or frightening sensations when drinking		-4.40 (0.21)	2.09 (0.15)
ADS 21. Felt things crawling on you has a result of drinking		-3.70 (0.16)	1.93 (0.13)
DSM. Meets criteria for physical dependence		1.58 (0.12)	0.77 (0.14)
	<i>Gender</i>	0.69 (0.16)	0.54 (0.18)
LDQ 2. Drinking more important than anything else...		-1.65 (0.25)	3.75 (0.47)
	<i>Age</i>	0.04 (0.02)	-0.10 (0.03)
LDQ 3. Feel your need for drink is too strong to control		2.85 (0.26)	2.28 (0.28)
LDQ 4. Plan your days around getting and drinking alcohol		-0.94 (0.20)	3.63 (0.43)
LDQ 7. Feel you have to carry on drinking once you have started		1.27 (0.17)	2.66 (0.29)
LDQ 8. Getting the effect you want more important than the particular drink		0.21 (0.11)	1.66 (0.17)
LDQ 9. Want to drink more when the effect starts to wear off		-0.08 (0.14)	2.61 (0.27)
LDQ10. Difficult to cope with life without a drink		-0.11 (0.14)	2.38 (0.24)

Note. All covariate effects (in *italics*) significant at $p < 0.05$. ADS=Alcohol Dependence Scale; DSM=Diagnostic and Statistical Manual for Mental Disorders; LDQ=Leeds Dependence Questionnaire; SE=standard error. Gender (0=female; 1=male); Marital Status (0=non married; 1=married or cohabitating); Study (0=COMBINE; 1=MATCH Outpatient, MATCH Aftercare, RREP, UKATT).

Table 4

Correlations between MNLFA Scores, ADS Total Scores, LDQ Total Scores, and Baseline Measures of Alcohol Consumption

	MNLFA scores	ADS	LDQ	DSM	N	M (SD)
MNLFA scores					4405	-0.06 (0.88)
ADS	0.83**				3627	17.51 (8.24)
LDQ	0.95**	--			732	15.68 (8.06)
DSM	0.43**	0.28**	--			
PDD	0.10**	-0.03	0.16**	0.04*	4393	72.67 (28.04)
DDD	0.45**	0.46**	0.31**	0.23**	4393	16.08 (11.11)
DrInC	0.56**	0.63**	--	0.24**	3291	52.03 (23.42)
APQ	0.36**	--	0.39**		737	14.69 (6.29)

Note.

* $p < 0.05$;

** $p < 0.01$;

MNLFA=moderated nonlinear factor analysis scale scores; ADS=Alcohol Dependence Scale; LDQ=Leeds Dependence Questionnaire; DSM=Diagnostic and Statistical Manual for Mental Disorders, Physiological Dependence; PDD=Percent Drinking Days; DDD=Drinks per Drinking Day; DrInC=Drinker Inventory of Consequences; APQ=Alcohol Problems Questionnaire.